



June 6, 2019

Ms. Marlene Dortch
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, D.C. 20556

Re: Additional Information on Proposal for Mean Opinion Score Testing Framework,
WC Docket 10-90

Dear Ms. Dortch:

Hughes Network Systems, LLC ("Hughes") submits this *ex parte* letter, at the request of Wireline Competition Bureau staff, to supplement its earlier filing on its proposal for the Mean Opinion Score (MOS) testing requirement for voice quality that the FCC adopted in 2014 for satellite operators that receive Connect America Funds.¹ As Hughes has explained earlier in this proceeding, this approach should only be used on a prospective basis. This *ex parte* details the two-pronged approach that Hughes proposes in more detail than Hughes has submitted into the record to date. As explained below, the Hughes proposal for monitoring voice quality involves a combination of the following two components:

1. **Laboratory subjective testing** of voice quality over the operational satellite network to establish a baseline of network parameters necessary to achieve the required conversational MOS performance.
2. **Monitoring of the operational network** to verify that the network parameters meet or exceed the baseline requirements established by the laboratory testing.

Each of these components are discussed further below.

1. **Laboratory Subjective Conversational MOS Testing to Establish Baseline Network Parameters**

In order to establish a baseline of the network parameters for MOS testing, the Hughes proposal relies on laboratory testing. This testing will establish the baseline network parameters under which a conversational MOS quality of 4.0 is achieved over an

¹ *Connect America Fund, ETC Annual Reports and Certifications*, Report and Order and Further Notice of Proposed Rulemaking, 29 FCC Rcd 8769, 8780 ¶¶ 29 (2014).

operational satellite network that is being used to provision CAF-supported offerings under well controlled ambient conditions.

The procedure for the laboratory tests would be conducted in compliance with the procedures set out in the ITU-T P.800 and P.805 recommendations,² to establish a baseline for network parameter values necessary to achieve the required voice quality. The test would run as follows:

- I. Conduct conversational MOS tests wherein a phone call is established over the operational satellite network between two VoIP end points in the laboratory and a subject-pair converse over the VoIP connection.
 - a. The number of subjects and test conditions shall be configured to achieve a MOS of 4.0 with a 95% confidence interval of +/- 0.3. The recommended procedure for the computation of MOS and confidence interval are described in ITU-T P.805 Appendix II.³
 - b. Tests are to be conducted using untrained subjects selected in accordance with the guidelines provided in ITU-T P.805 Section 6.5.⁴
 - c. Tests are to be conducted with the satellite communications equipment, voice codec(s) and bit rate(s) employed for the VoIP service and the CPE if provided to the VoIP customers.
 - d. Record the voice quality related network parameters that were in effect during the subjective test. The network parameters that impact the voice quality are: (i) voice codec and the operational bit rate, (ii) latency, (iii) packet loss, and (iv) jitter. These parameters can be obtained from the Call Data Records, collected by the media gateway for each phone call.

The results of these tests will then be used to establish the baseline of objectively measurable network parameter values that guarantee the conversational MOS of 4.0 with a 95% confidence interval of +/- 0.3.

Testing is repeated to reestablish the baseline annually. Testing is also repeated whenever there is a substantive change to the network architecture (e.g., selection of a new voice codec, new bit rate, or new CPE).

² ITU-T Recommendation P.800 (1996), *Methods for subjective determination of transmission quality*, available at <https://www.itu.int/rec/T-REC-P.800-199608-I/en>; ITU-T Recommendation P.805 (2007), *Subjective evaluation of Conversational quality*, available at <https://www.itu.int/rec/T-REC-P.805/en> ("Subjective Evaluation Standard").

³ *Subjective Evaluation Standard*.

⁴ *Id.*

2. Monitoring of Operational Network

The next step is monitoring of the operational network in order to evaluate compliance with the MOS 4.0 score. The delay and packet loss characteristics are measured for a certain number of randomly selected sites. Consistent with the order on voice performance testing issues by the Commission's Wireline Competition Bureau, Wireless Telecommunications Bureau, and Office of Engineering and Technology on July 6, 2018,⁵ Hughes supports the selection of 100 MOS Test Locations for providers with 3500 or fewer CAF-supported Voice Locations, or 370 testing locations for providers with greater than 3500 CAF-supported Voice Locations.

The actual network parameters will be measured using Call Data Records, collected by the media gateway for each phone call made by or to the selected site. Measurements of the observed latency, jitter, and packet loss will be recorded from each call, and for each site, compliance shall be defined as a condition in which at least 80% of the observations meet or exceed 80% of the established network characteristics. This is consistent with the 80/80 standard for measuring speed as defined by Commission staff in the *Voice Standards Order*.⁶

Hughes provides the following example to further clarify the above methodology. This example relies on entirely hypothetical numbers.

I. Example Laboratory Subjective Testing of Conversational MOS:

Conversational subjective tests are conducted over the operational satellite network, using the G.711 uLaw PCM codec at 64 kbps rate. The tests result in a conversational MOS of greater than 4.0 with a 95% confidence interval of 0.2. Satellite network parameter values (latency, packet loss and jitter) during the tests are obtained using the call data records. Over the duration of the tests, these parameters have the following average values:

- Latency = 600 msec
- Jitter = 15 msec
- Packet loss = 0.5 %

These values are used to establish the following baseline values using the 80/80 standard established by the FCC:

- Maximum Latency = $600 \text{ msec} / 0.80 = 750 \text{ msec}$
- Maximum Jitter = $15 \text{ msec} / 0.80 = 18.75 \text{ msec}$
- Maximum Packet loss = $0.5 \% / 0.80 = 0.625 \%$

Because latency, jitter, and packet loss are inversely correlated with voice quality levels, the baseline values are obtained by dividing by a factor of 0.80.

⁵ *Connect America Fund*, Order, 33 FCC Rcd 6509 (WCB, WTB, OET 2018) ("Voice Standards Order").

⁶ *Id.* ¶ 51.

II. Example Monitoring of Operational Network

The parameter values as determined above, based on the subjective test results and the 80/80 standard, are used as the baseline to verify compliance. In-network monitoring is performed, and call data records are collected from actual voice calls (from/to VoIP customers). The records indicate that:

- All calls were made using the G.711 uLaw voice codec at 64 kbps rate, and
- For 92% of calls:
 - Latency \leq 750ms, and
 - Jitter \leq 18.75ms, and
 - Packet Loss \leq 0.625%.

These results confirm that the network is operating in compliance to the required service level.

Hughes urges the FCC to adopt this procedure to determine compliance for satellite operators with the MOS testing regime.

Respectfully submitted,

/s/ Jennifer A. Manner

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